Development of the "SANUPS P61B" 5.5 kW Type Power Conditioner for Photovoltaic Power Generation

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1. Introduction

In recent years there has been an increase in photovoltaic power systems and other power generation equipment which use renewable energy, spurred on by the demands from society for energy which considers the global environment. In particular, the heightened concern for CO_2 reduction as a means of preventing global warming is creating expectations towards power conditioner for photovoltaic power generation (hereinafter "power conditioners") to have even better motor efficiency. In addition, the feed-in-tariff for renewable energy which became effective in 2012 is another factor accelerating market expansion. Furthermore, recently there has been much attention on small-scale photovoltaic power systems which can effectively utilize limited space on the rooftops of cluster housing, retail stores, small offices and idle farming land.

In order to satisfy these requirements, Sanyo Denki has developed a new model with an output capacity of 5.5 kW and added it to our "SANUPS P61B" series of power conditioners for photovoltaic power generation. This report introduces this new model.

2. Background of the Development

In the photovoltaic power generation market, the majority of installations and operations focus on products designed for low voltage grids of less than 50 kW, which are considered comparatively simple, and as such a product with an output capacity optimal for low-voltage grid applications are in demand.

When configuring a system under 50 kW, which is the requirement for low voltage grids, 9 of the conventional 5 kW power conditioners would be required to configure 45 kW. In contrast to this, if the newly developed 5.5 kW type is used, 9 units would create a system with 49.5 kW, thus obtaining 10% more capacity with the same number of power conditioners and resulting in a system with optimal output capacity.

Below are the advantages of selecting the 5.5 kW model in a low-voltage grid.

System configuration under 50 kW

"With the 5 kW type power conditioner"

5 kW x 9 units = 45 kW

△ Minimal power generation

"With the 5.5 kW type power conditioner"

5.5 kW x 9 units = 49.5 kW

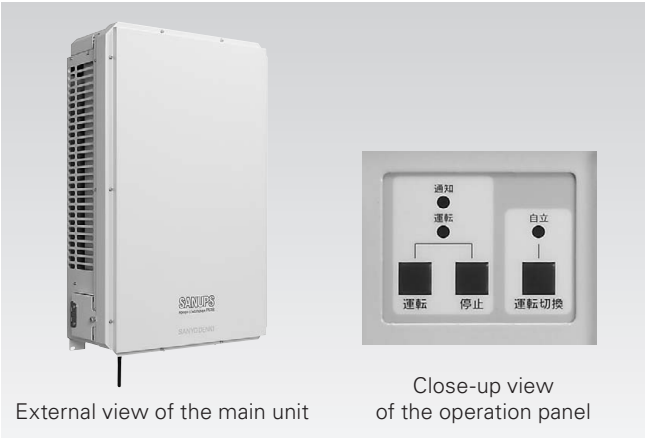
○ A configuration with the maximum capacity is possible

3. Product Overview

3.1 Power conditioner main unit

Fig. 1 shows an external view of the "SANUPS P61B" 5.5 kW. This power conditioner is the same size as the 5 kW but achieves 10% higher output capacity. One of the differences in appearance with the conventional model is the operation panel which has been added to the left- side. This operation panel improves operability and workability when performing maintenance operation checks.

Fig. 2 shows the main system configuration of this unit.



External view of the main unit

Close-up view of the operation panel

Fig. 1: External view of the "SANUPS P61B" 5.5 kW

PV Monitor + LCD panel TYPE III + P61B 5.5 kW x 9 units (49.5 kW)

Fig. 2: Main system configuration

3.2 LCD panel

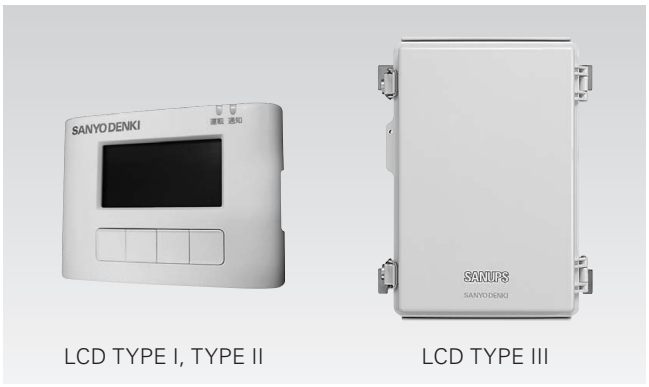
Table 1 lists the each type of LCD panels types and Fig. 3 shows the external view of the LCD panel.

This LCD panel makes it possible to operate or confirm internal operation of the "SANUPS P61B" 5.5 kW main unit. Communication with the main unit can be either via wired connection or wireless connection, and in addition to "TYPE I" which enables operation of up to 3 P61B units, and "TYPE II", which enables operation of up to 10 P61B units in a wired connection. Moreover, we have newly developed "TYPE III" which can be used with a Sanyo Denki remote monitoring tool "SANUPS PV Monitor" which can be installed outdoors. In the case of wired connection, power is supplied from the "SANUPS P61B" 5.5 kW main unit and isolated operation is possible in the event of a power outage. Wireless connection adheres to the IEEE802.15.4*1 standard which utilizes the 2.4 GHz frequency range, making it able to be installed anywhere.

Moreover, the display uses an LCD display with a 128 x 64 dot matrix able to display 5 lines of 10 full-width characters (20 single-byte characters), which may include the alphabet, numbers and Chinese characters, thus improving legibility and providing equipment information in a straight-forward way. Operations are performed using the four buttons at the bottom of the screen and the operation details are displayed on the screen, making for a user-friendly user interface with excellent design.

Table 1: A list of LCD panels by type

LCD type	Installation location	No. of power conditioners able to be operated	Communication method	Joint use with PV Monitor
TYPE I	Indoors	1 to 3 units	Wireless/wired choices available	-
TYPE II	Indoors	1 to 10 units	Wired	-
TYPE III	Outdoors/ indoors	1 to 10 units	Wired	○



LCD TYPE I, TYPE II LCD TYPE III

Fig. 3: External view of the LCD panel

4. Features

4.1 High efficiency

The main circuit for the "SANUPS P61B" 5.5 kW uses a non-insulating method that does not use an insulation transformer. Moreover, optimum part selection and circuit design have led to reduction of heat loss and higher efficiency.

In general, switching frequency must be lowered in order to reduce switching loss which can cause high frequency noise to occur, however our optimum design achieves both high efficiency and low noise which is explained next.

As a result, the "SANUPS P61B" 5.5 kW has achieved top class conversion efficiency in the industry*2 at 95%*3.

4.2 Ultra low noise

In order to achieve ultra low noise, the "SANUPS P61B" series was developed with fan-free and less inverter high frequency noise (mosquito noise).

4.3 Superior environment resistance

By adopting a sealed structure, the "SANUPS P61B" 5.5 kW is dust resistant and splash proof to the level of protection required by IP65*4. This structure protects the device from ingression of rain, dust, small bugs, or animals to make a highly reliable product that customers can use for long periods of time outdoors with great security. It can also be used in regions with the risk of salt damage. *5

4.4 Isolated operation function

With the "SANUPS P61B" 5.5 kW is possible to switch isolated operation mode by a manual operation from the operation panel. The output method during isolated operation is two-wire 101 V with an output of 2.5 kW, therefore even if a power outage occurs, as long as the photovoltaic power system is generating power, this can be used as emergency power for equipment, etc.

4.5 Connecting box function

The "SANUPS P61B" 5.5 kW is standardly equipped with a connecting box function that allows to input max four circuits. Moreover, the new model also supports DC batch input, therefore is compatible with a diversity of photovoltaic module system configurations.

Two independent converters have been equipped and by devising different ideas for connection, it is also able to support anything from a 1 to 4 string connection (a "string" is that multiple photovoltaic modules are connected in series.)

4.6 Islanding operation prevention function

The "SANUPS P61B" 5.5 kW is equipped with an islanding operation prevention function which conforms to JEM1498, the "standard form of active islanding operation detection for power conditioners for photovoltaic power generation". This means it is not necessary to submit documentation to prove there will be no interference as a result of power conditioner combination at the time of grid negotiation.

4.7 Fault-ride-through function (FRT)

The "SANUPS P61B" 5.5 kW has satisfied the requirements for continuing operation in the event of an incident, which must be corresponded from April, 2017, as stipulated in the utility connected system regulation, JEAC9701-2012. By satisfying a future requirement in this way, it is possible to avoid unnecessary disconnection and minimize impact on the system.

5. Circuit Configuration

This device is configured from a booster converter circuit, inverter circuit, control circuit, utility protective circuit, communication circuit, etc. Fig. 4 shows a circuit block diagram.

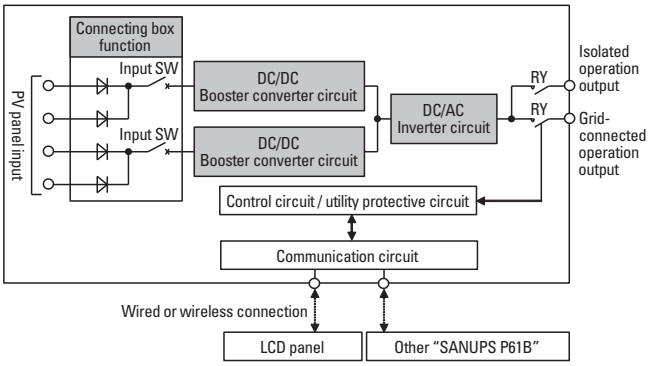


Fig. 4: Circuit block diagram

5.1 MPPT circuit

The "SANUPS P61B" 5.5 kW model is equipped with two MPPT circuits. Even if the voltage of the two strings connected to the input circuit differs, power generation efficiency can be improved by efficiently extracting the electricity generated by each strings.

5.2 Communication circuit configuration

Communication between the power conditioner and LCD panel is either wired or wireless.

The wired connection interface uses RS-485. RS-485 adopts a balanced channel with a twisted-pair cable and achieves relatively stable communication over long distances. The communication protocol adheres to the Modbus protocol and increases the freedom of the customer in regards to system configuration.

Moreover, a wireless communication function adopting the IEEE802.15.4 standard is a standard feature, therefore when wireless connection is used, communication cable installation work can be omitted.

6. Operational Advantages

6.1 Can be installed anywhere

Due to the low noise of the "SANUPS P61B" 5.5 kW, it does not need to be located far from residential areas and can be operated with reliability in places where people pass regularly and near buildings. It is also able to withstand environments such as vacant agricultural land, etc. where people do not normally go, therefore providing long-term usage with reliability. The ability to install the "SANUPS P61B" 5.5 kW anywhere is a big advantage to system integrators and mass retailers who receive a widerange of installation requests from customers.

6.2 Easy introduction

The "SANUPS P61B" 5.5 kW adopts single-phase, three-wire output, therefore there is no need to prepare an insulation transformer. Moreover, it has acquired JET certification[*6] as an outdoor power conditioner for photovoltaic power generation. This will reduce the time and cost customers must invest in discussing connection with electricity power companies.

6.3 Utilization as a string inverter

If the strings of photovoltaic panels are stacked in parallel and the battery capacity is increased, the voltage of each string must be made equal in order to extract the maximum power generated from common power conditioners. As a means to overcome this, it is possible to install power conditioners for each string and this form of usage is referred to as "string inverter".

The "SANUPS P61B" 5.5 kW is an ideal power conditioner for use as a string inverter and by configuring a system with multiple units or using two MPPT circuits it is possible to extract the power generated by each individual string and increase the power generation efficiency of the overall system. This method of utilization is advantageous for photovoltaic power systems installed in limited spaces such as the rooftops of cluster housing, retail stores and small businesses. Fig. 5 shows an example of utilization as a string inverter. The operational status and power generation status of the respective power conditioners differs depending on each string, however it is possible to batch monitor these using the LCD operation panel and the "SANUPS PV Monitor".

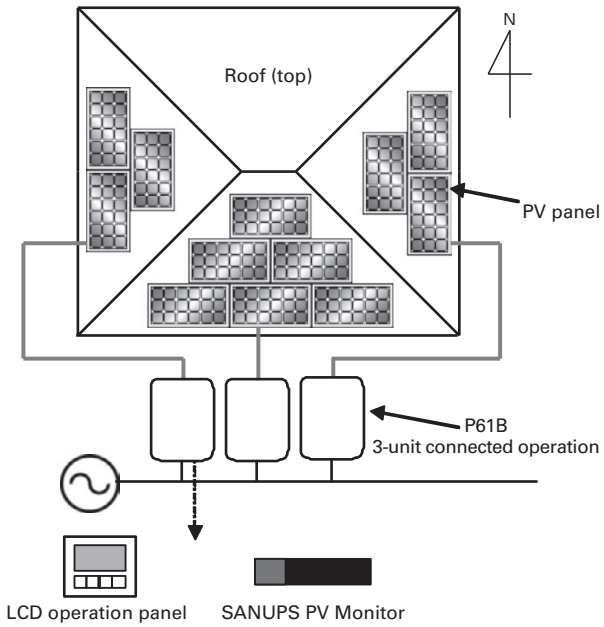


Fig. 5: An example of utilization as a string inverter

7. Options

7.1 "SANUPS PV Monitor"

By connecting the "SANUPS P61B" 5.5 kW with our "SANUPS PV Monitor", data can be collected and analyzed via a LAN, including data such as the status and measurements of power conditioners. Fig. 6 shows an image of the connections when using the "SANUPS PV Monitor".

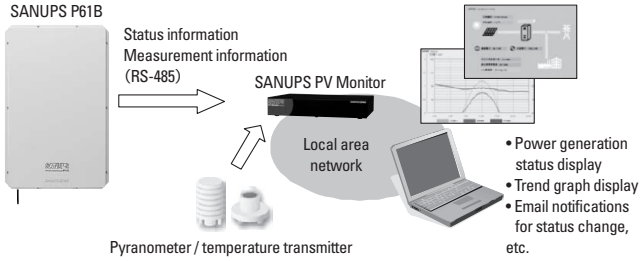


Fig. 6: Image of connection to the "SANUPS PV Monitor"

7.2 "SANUPS NET"

With the "SANUPS P61B" 5.5 kW, by using our "SANUPS NET" it is possible to remotely collect and analyze data such as the status and measurements of power conditioners on a PC or smartphone via the Internet.

If a system is configured in a location where there is no wired Internet line, by using the "SANUPS PV Monitor" and a mobile router in a "Mobile Communication Pack" which is implemented in a splash proof box, it is possible to use the service through a mobile communication network. This is effective when installing the device in environments such as outdoors or on rented rooftops. Fig. 7 shows a connection image of "Mobile Communication Pack".

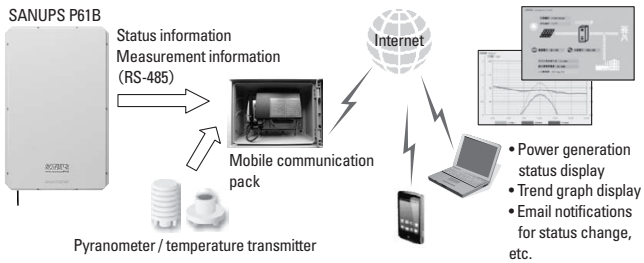


Fig. 7: A connection image of "Mobile Communication Pack"

8. Specifications

Table 2 shows the general specifications of this unit.

Table 2: General specifications for the “SANUPS P61B” 5.5 kW

Item \ Model			P61B552SJ001	Remarks
Rated output capacity		During grid-connected system operation	5.5 kW	
		During isolated operation	2.5 kW	
Insulation method			Without insulation transformer	Transformer-less system
DC input	Rated voltage		280 V DC	
	Input voltage range		0 to 450 V DC	
	Input operating voltage range		60 to 450 V DC	Startup voltage: 80 V DC Rated output range: 200 V to 400 V DC (With suppression of output by temperature)
	No. of input circuits		Connecting box function input: 4 circuits, MPPT circuit direct input: 2 circuits	Batch input possible
	No. of MPPT circuits / mode		2 circuits/batch mode, 2 systems isolated mode	
	Max. current capacity	Total/MPPT circuits	32 A / 16 A	
		Connecting box function input	9.5 A	
AC output	No. of phases/wires		Single-phase, three-wire	
	Rated voltage	During grid-connected system operation	202 V AC	
		During isolated operation	101 V AC	Single-phase, two-wire
	Rated frequency		50 Hz / 60 Hz	
	AC output current distortion rate		5% or less of the total current, 3% or less of each next harmonic wave	Rated output current ratio
	Output power factor		0.95 or higher	During utility connected system operation/rated output
Efficiency			95%	Efficiency measurement method based on JIS C 8961
Communication method			Wired: RS-485, Wireless: IEEE802.15.4	
Cooling system			Natural air-cooling	
Utility protection function			Over-voltage (OVR), under-voltage (UVR), over-frequency (OFR), under-frequency (UFR)	
Islanding operation detection		Passive method	voltage phase jump detection method	
		Active method	Frequency feedback method with step injection	
Multiple unit linkage function			Yes	
Acoustic noise			28 dB or less	A characteristic, front 1 m
Operating ambient temperature			-20 to +60˚C	(With suppression of output by temperature)
Waterproof /dust-resistant protection level			IP65	Main unit

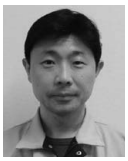
9. Conclusion

As photovoltaic power generation becomes more popular in the future, the system configurations will become more diversified and there will be a demand to further enhance power conditioner products. Moreover, we believe there will be an increased demand for power conditioners to be even more reliable, efficient, sophisticated and low cost.

We will continue to quickly develop products to meet these market demands and provide the products that fulfill our customers' needs.

We would like to express our deep gratitude for the cooperation and guidance of our working group and all related persons who helped to achieve success in this latest development and commercialization project.

*1: IEEE802.15.4 is a standard formulated by IEEE, which is headquartered in the USA.
*2: As of August 2014. For power conditioners for photovoltaic power generation with the same capacity for use within Japan. Results from Sanyo Denki inspection.
*3: Rated load efficiency based on "JIS C 8961 Measuring procedure of power conditioner efficiency for photovoltaic systems".
*4: Classification defined in "JIS C 0920 Degrees of protection provided by enclosures (IP Code)".
IP65: Protection against ingression of dust and water spray from all directions.
*5: Excluding locations 300 meters or less from the coastline or locations directly subjected to seawater or seawater spray. The exterior of the power conditioner may discolor or rust even in regions where installation is possible.
*6: JET: Japan Electrical Safety & Environment Technology Laboratories



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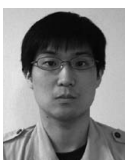

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